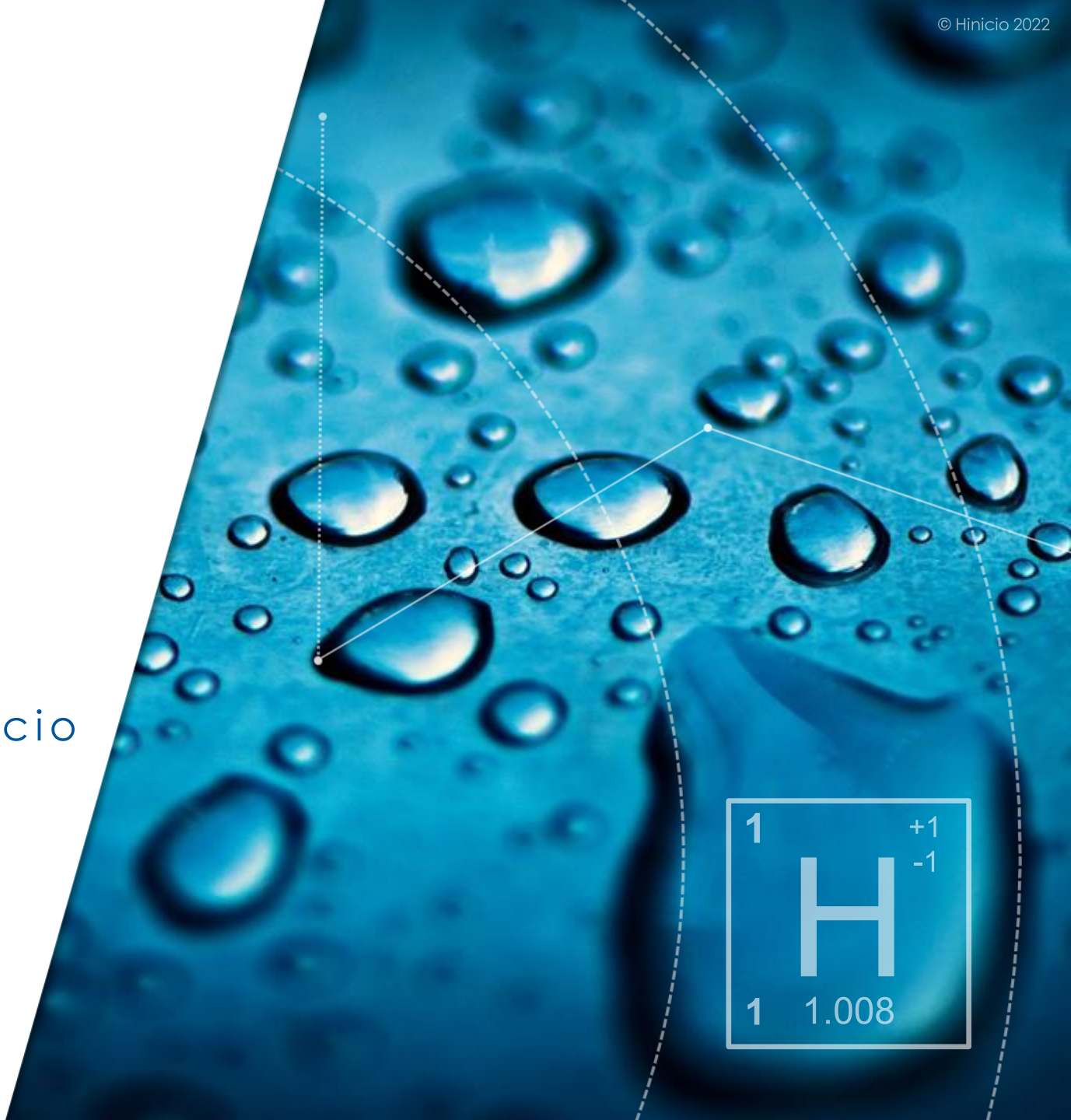
4th Neltume Ports Alignment Meeting

Green Hydrogen

Nuria Hartmann
Manager Strategy Consulting Hinicio
October 6, 2022

NELTUME PORTS
Empowering Trade



Contents

1 A few words about Hinicio

ABOUT HINICIO

STRATEGY CONSULTANTS IN ENERGY & SUSTAINABLE MOBILITY

Founded in 2006, **we are recognized as a European Leader in the hydrogen and fuel cells industry.**

Our vision

At Hinicio, **we see hydrogen as playing a central role in the future energy system to achieve climate objectives.**

It is **our mission** to advise our clients and support the **building of successful strategies, projects, and public policies**, leading and accelerating the transformation of the energy system globally. By doing so, we strive to be the preferred partner and attract best-in-class human capital.

We have offices in **Brussels, Paris, Rotterdam, Washington DC, Bogotá and Santiago**, and commercial representation in **Mexico and China.**

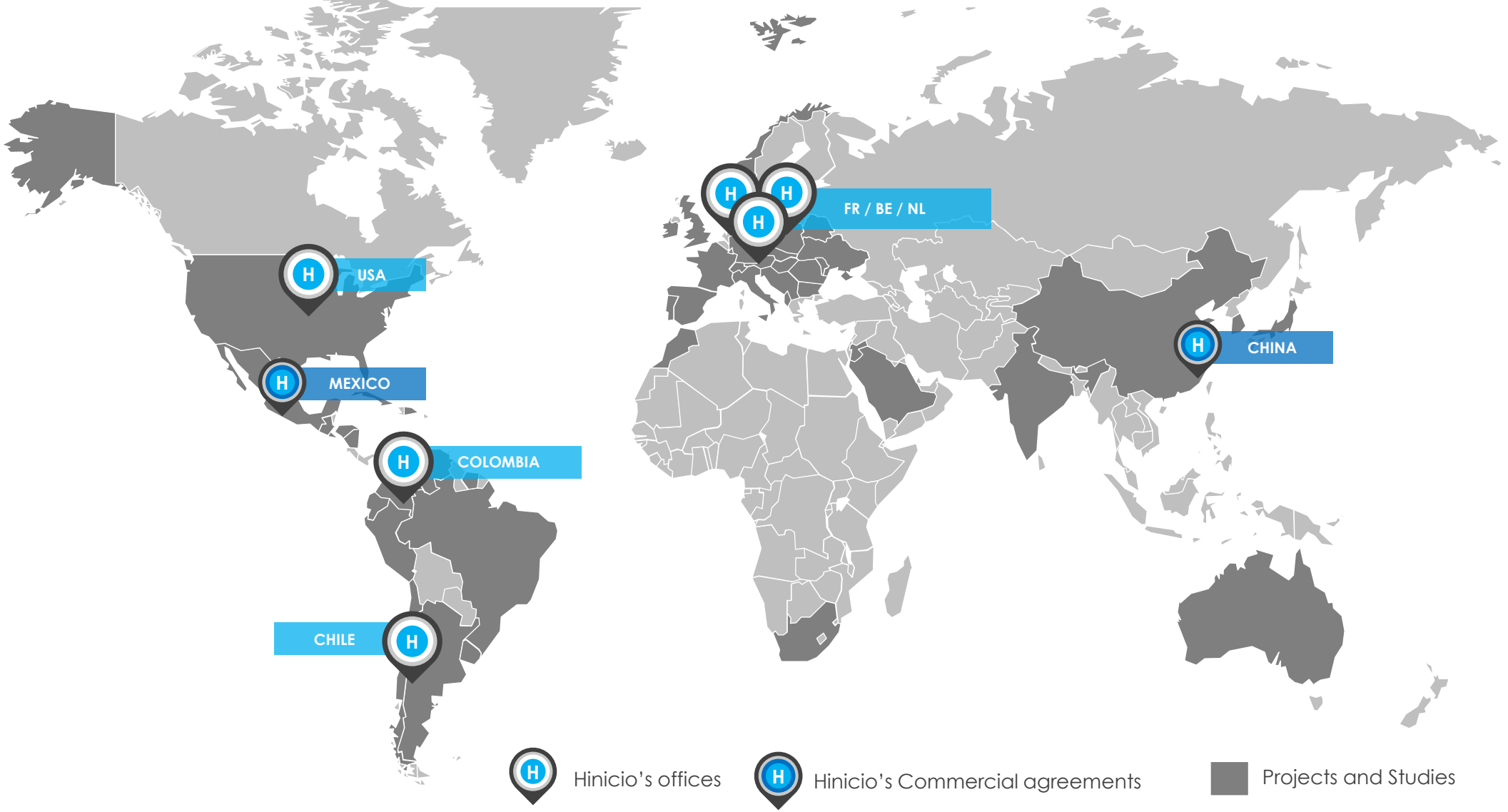
STRATEGY

INVESTMENT

PUBLIC POLICIES

PROJECTS DEVELOPMENT

+500 studies and projects in more than 25 countries



SOME OF OUR CLIENTS

Experience in the whole value chain in the energy and transport sector

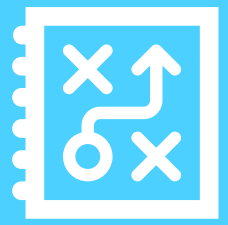
PRIVATE SECTOR

- Transnational companies
- SMEs & Start-ups
- Investors
- Trade associations
- Blue chips

PUBLIC SECTOR

- International organizations and donors
- EU institutions
- National bodies
- Public entities
- Local authorities

OUR TAILOR-MADE CONSULTING SERVICES



Business & Strategy Consulting

- Market Intelligence & Research Studies
- Corporate & Competitive Strategy
- New Business Case Analysis & Financial Modeling
- Market Entry & Go-to-Market Strategy
- Tactical Plans & Roadmaps
- Value Chain Analysis

M&A AND INVESTMENT SUPPORT

- Investment strategy
- Deal origination
- Strategic Due Diligence (Vendor)
- Technical Due Diligence (Vendor)
- Commercial Due Diligence (Vendor)Public funding

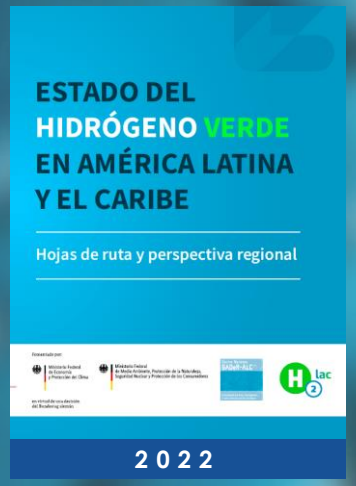
POLICY AND REGULATORY SUPPORT

- Economic studies
- Impact analysis ex-ante & ex-post
- Analysis of regulatory frameworks
- Workshops & Trainings

PROJECT DEVELOPMENT ASSISTANCE

- Prefeasibility and feasibility studies
- Energy systems modeling & optimization
- Business Model and HPA
- Site selection & permitting
- Certification & Regulatory compliance
- Subsidies & funding application
- PMO / consortium management

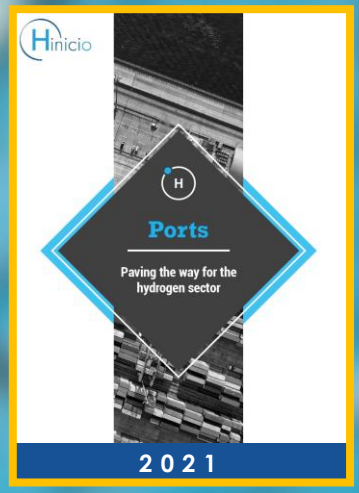
SOME OF OUR **PUBLICATIONS**



2022

2022

2021



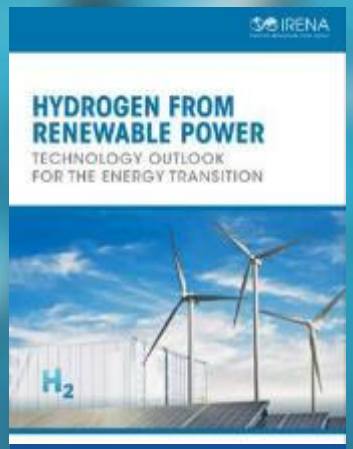
2021

2020

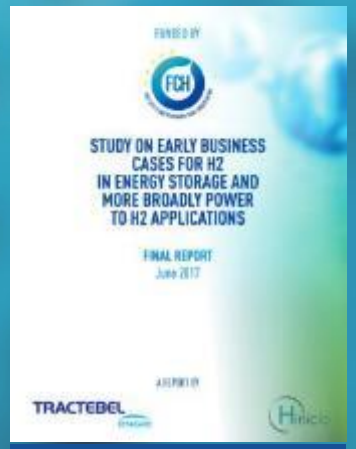
2020

2019

2018

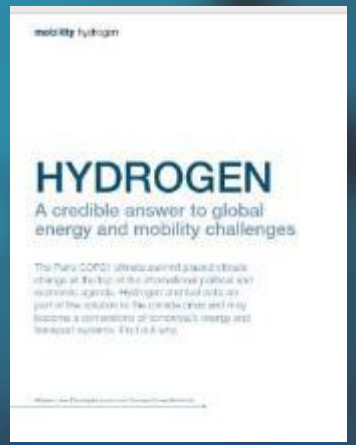


2018



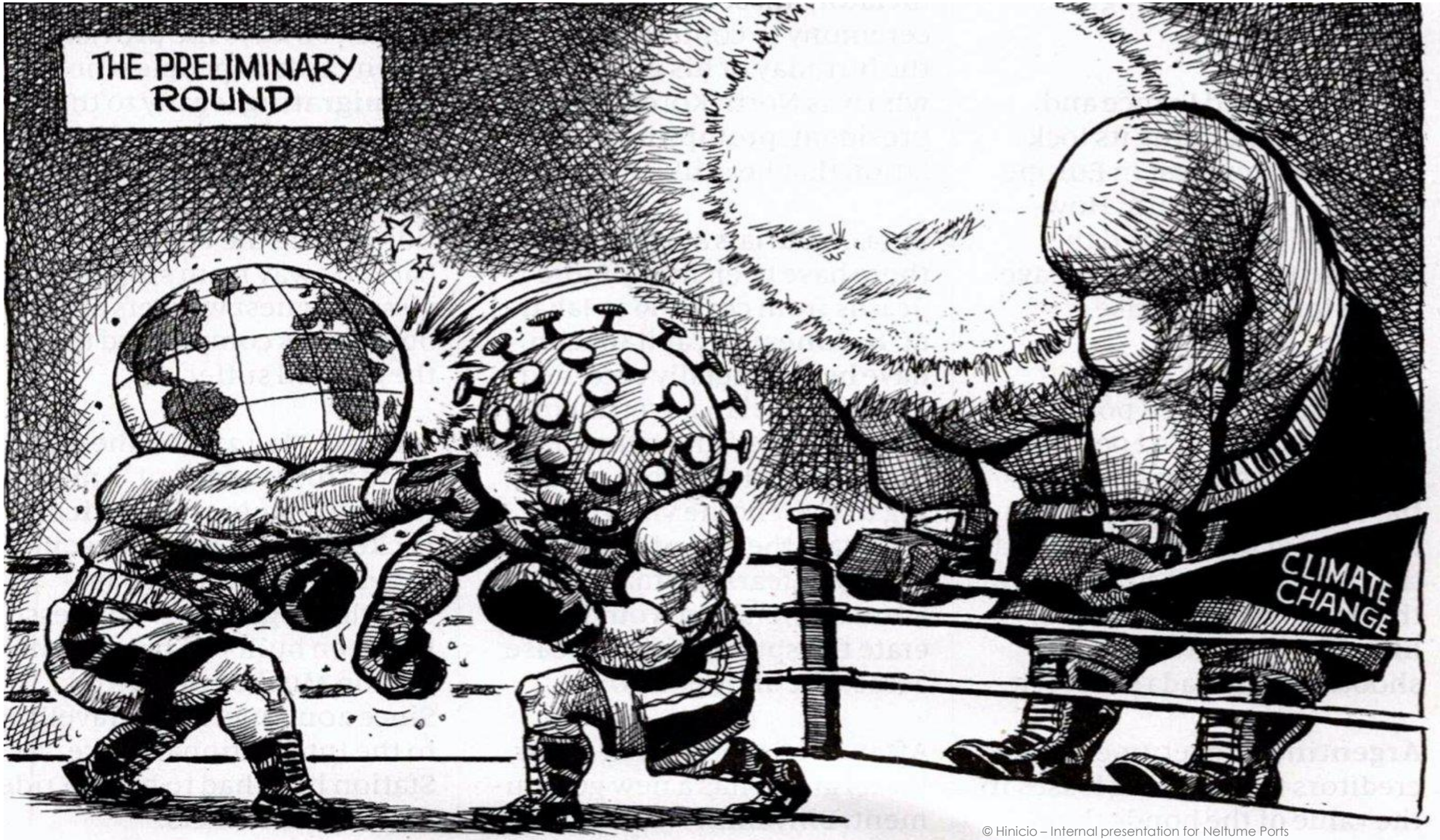
2017

2017



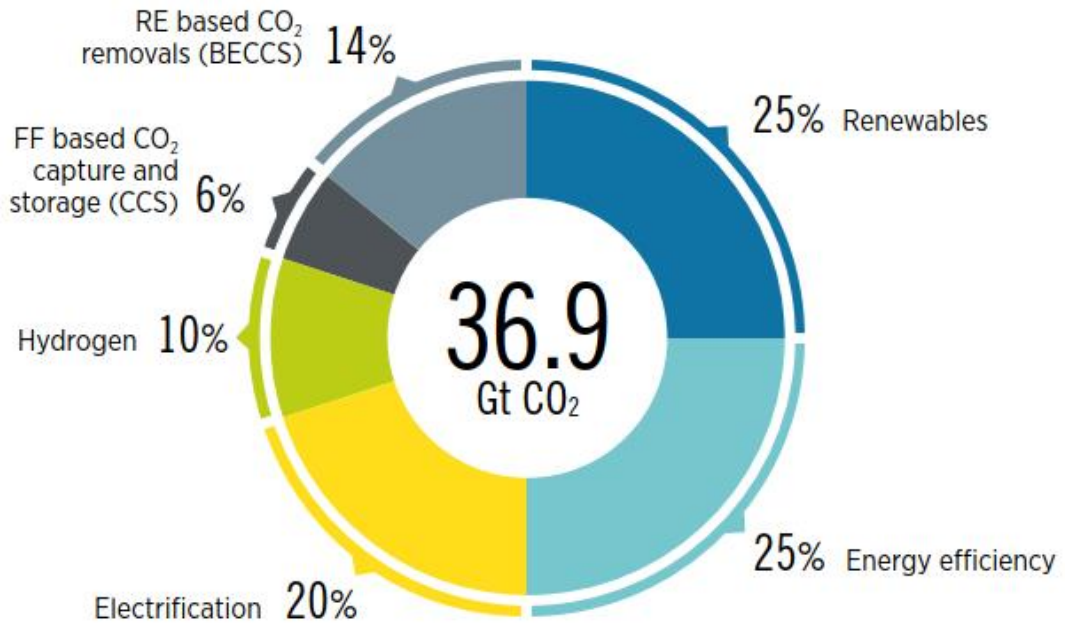
2016

2 Why H2 for decarbonization?



There are different options for decarbonization, but not all are feasible for all type of applications

Six Technological Pathways for CO_2 Emission Reduction



CCS = carbon capture and storage; BECCS = bioenergy with carbon capture and storage; GtCO2 = gigatonnes of carbon dioxide; RE = renewable energy; FF = fossil fuel.

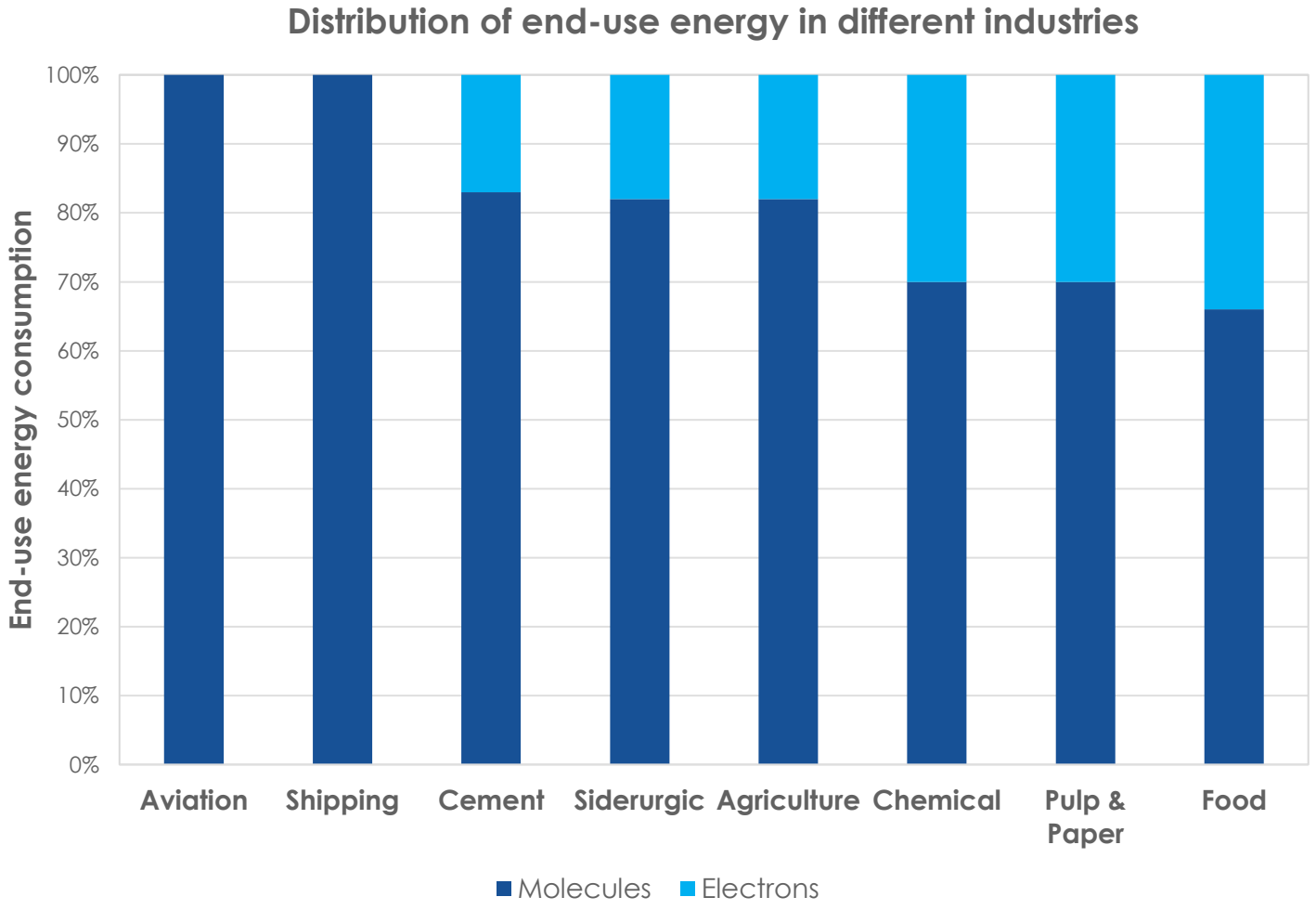
Source: IRENA (2022).

Hydrogen / Power-to-X

↓

Hard-to-abate sectors

Our current energy consumption is based on molecules which are mainly derived from fossil sources



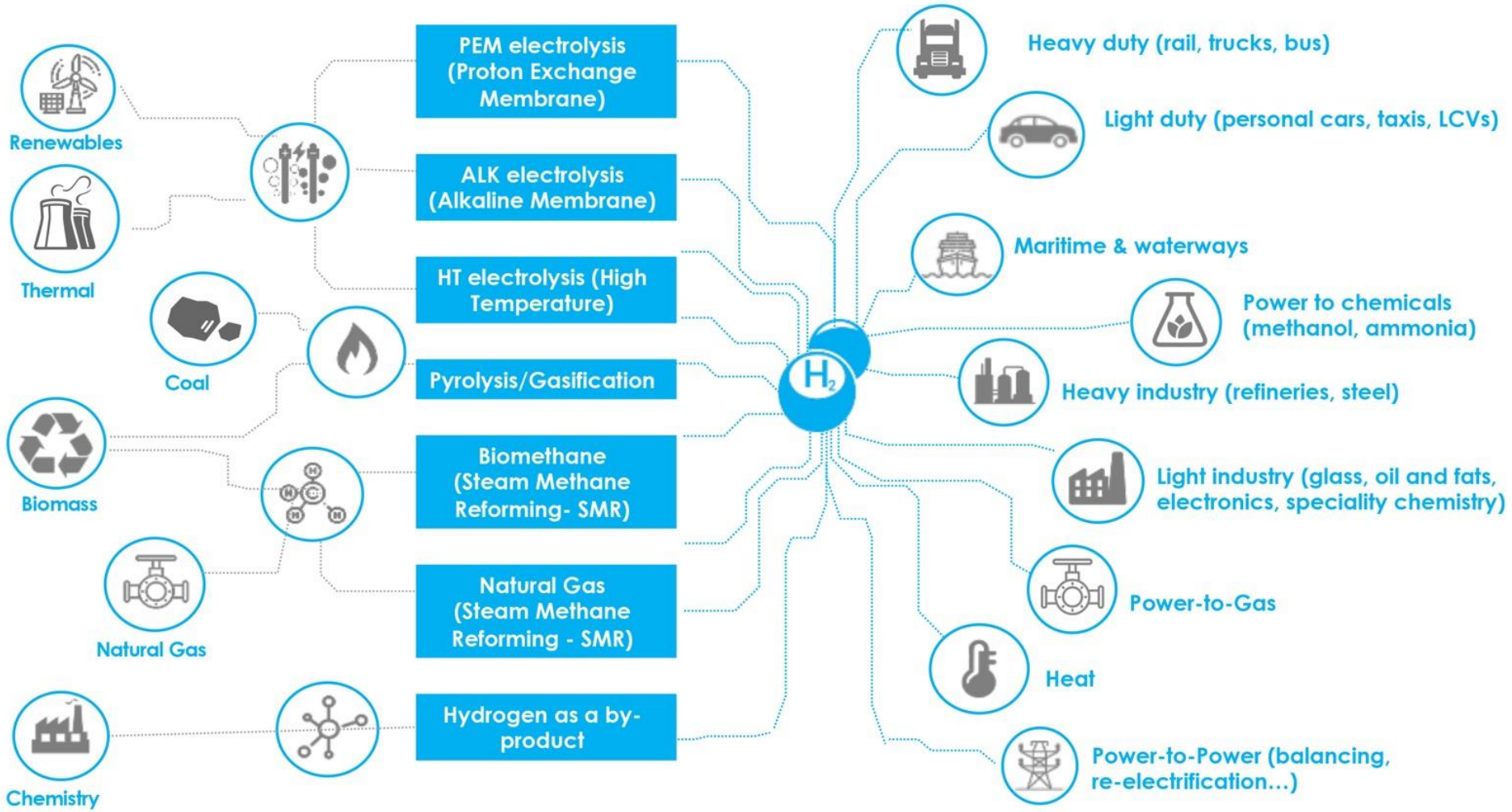
Source: Adapted from Bloomberg New Energy Finance, 2019

Many industries are in the **electrification** pathway, but others are still dependent on primary energy in the form of molecules → **Hard to abate sectors**

How to replace molecules without relying on fossil sources?

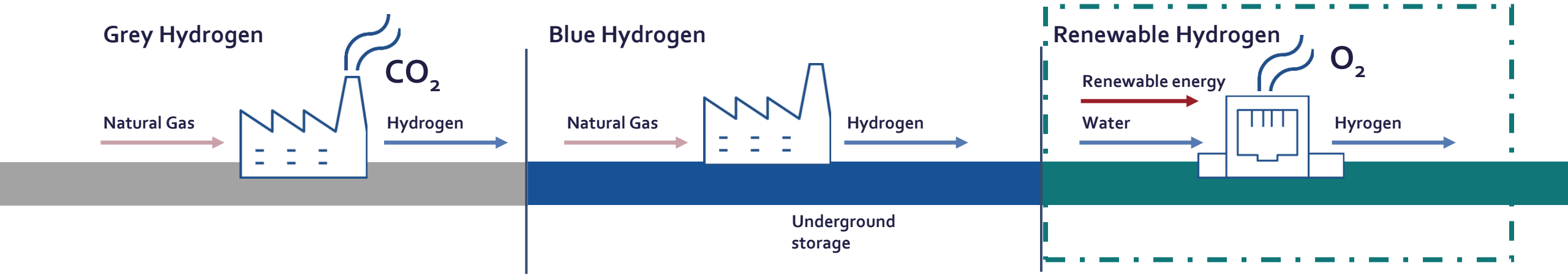
Hydrogen is a cornerstone in the energy transition to build decarbonized energy systems

HYDROGEN SOURCES AND USES

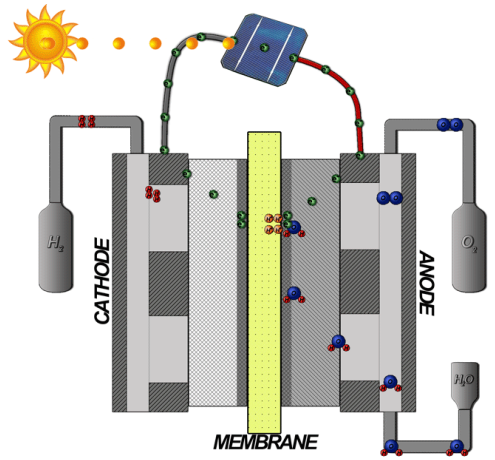


Hydrogen as an energy vector

How is renewable hydrogen produced?



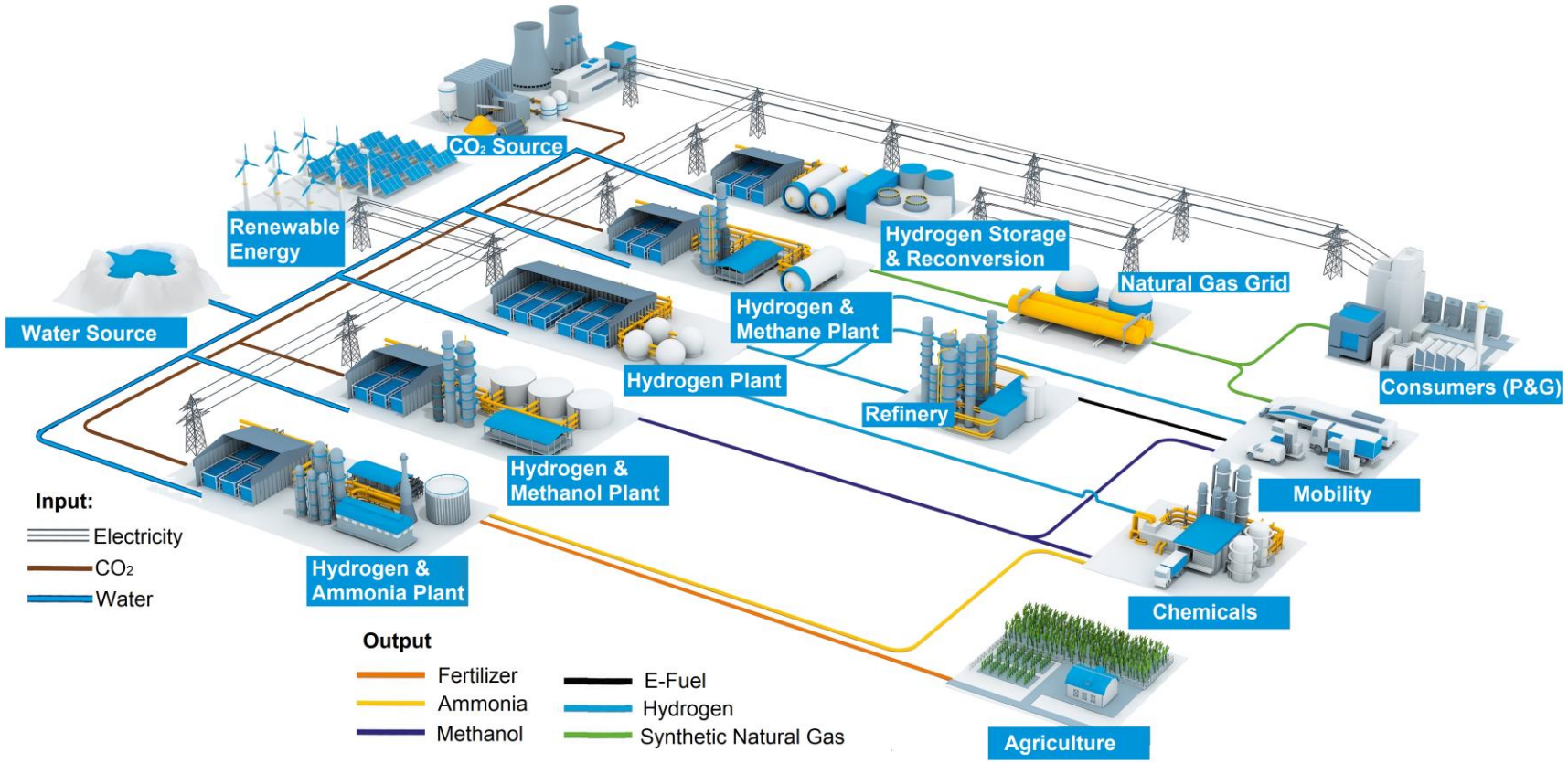
Electrolysis



- ***Hydrogen is the most abundant element in nature.***
- ***Hydrogen can be obtained from natural gas (called grey and blue hydrogen) or renewable electricity and water (renewable hydrogen).***
- ***The H2 molecule has a high energy density per mass unit (3 times more than gasoline and 120 times more than lithium batteries).***

Hinicio

Power-to-X: Renewable energy brought to all sectors of the economy



Source: Thyssenkrupp.

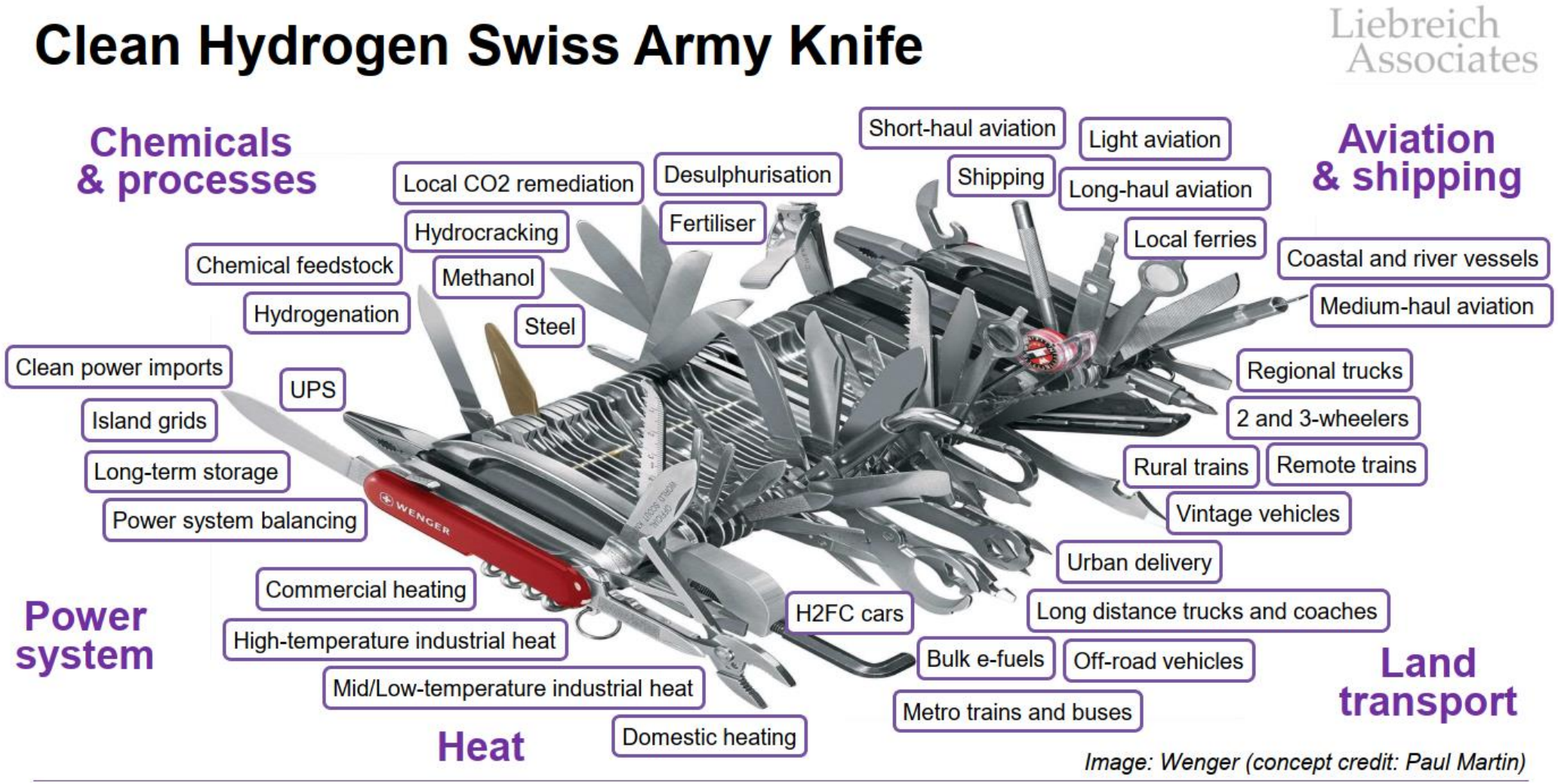
- Hydrogen's primary role in the energy transition is that of a **cost-efficient decarbonization vector across many sectors**, particularly those less suited for direct electrification.
- Hydrogen plays a critical role in **enabling stronger penetration of renewable power** to build **decarbonized energy systems.**
- **Hydrogen connects industries in novel ways**, e.g. clean power and energy with the metal, fuels, chemical, and petrochemical industries, **expanding the borders of previously separate sectors**.

Sector Coupling: Hydrogen is a **multi-purpose solution** connecting **different energy systems.**

Hydrogen has many potential uses and allows sector coupling…

v/s

BUT: Do not buy the hype! Hydrogen is not the solution to everything and everywhere. Remain focused!

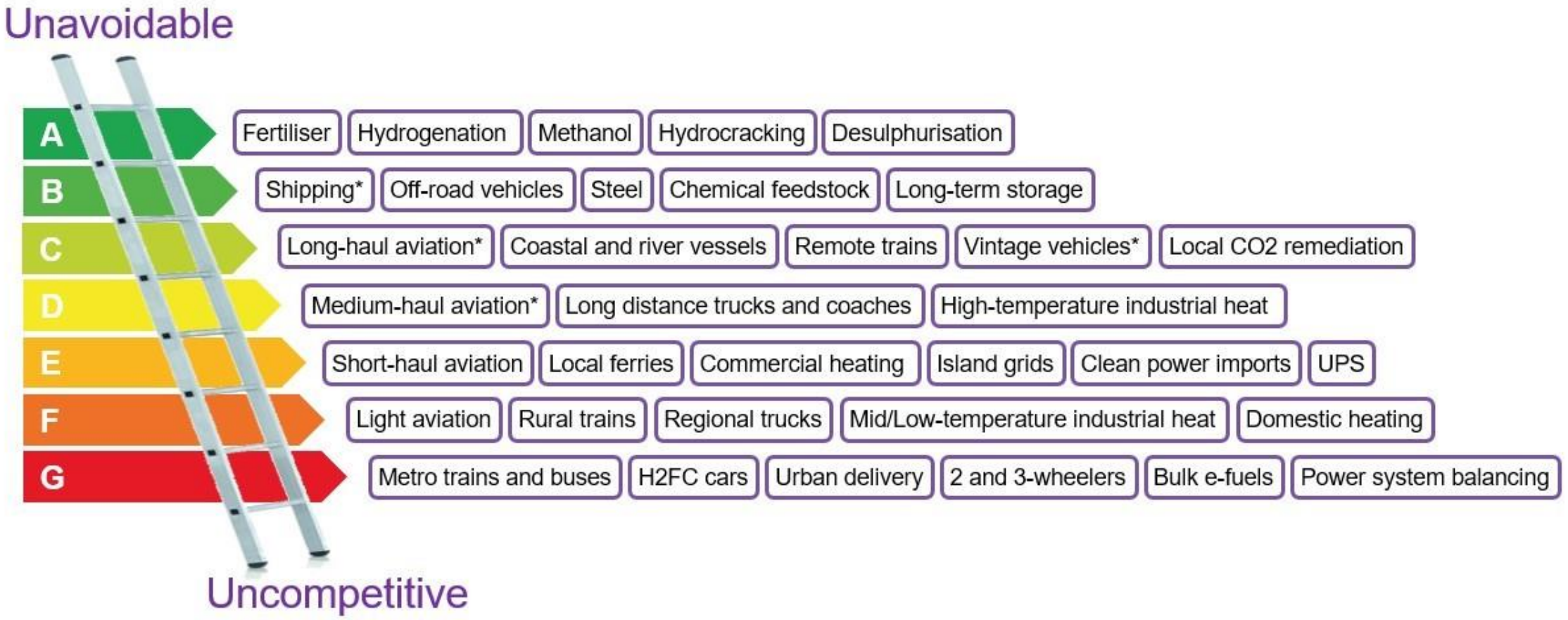


*Liquid Organic Hydrogen Carrier

Source: Clean Hydrogen Ladder, 2021

Shipping is among the "unavoidable" H2 applications

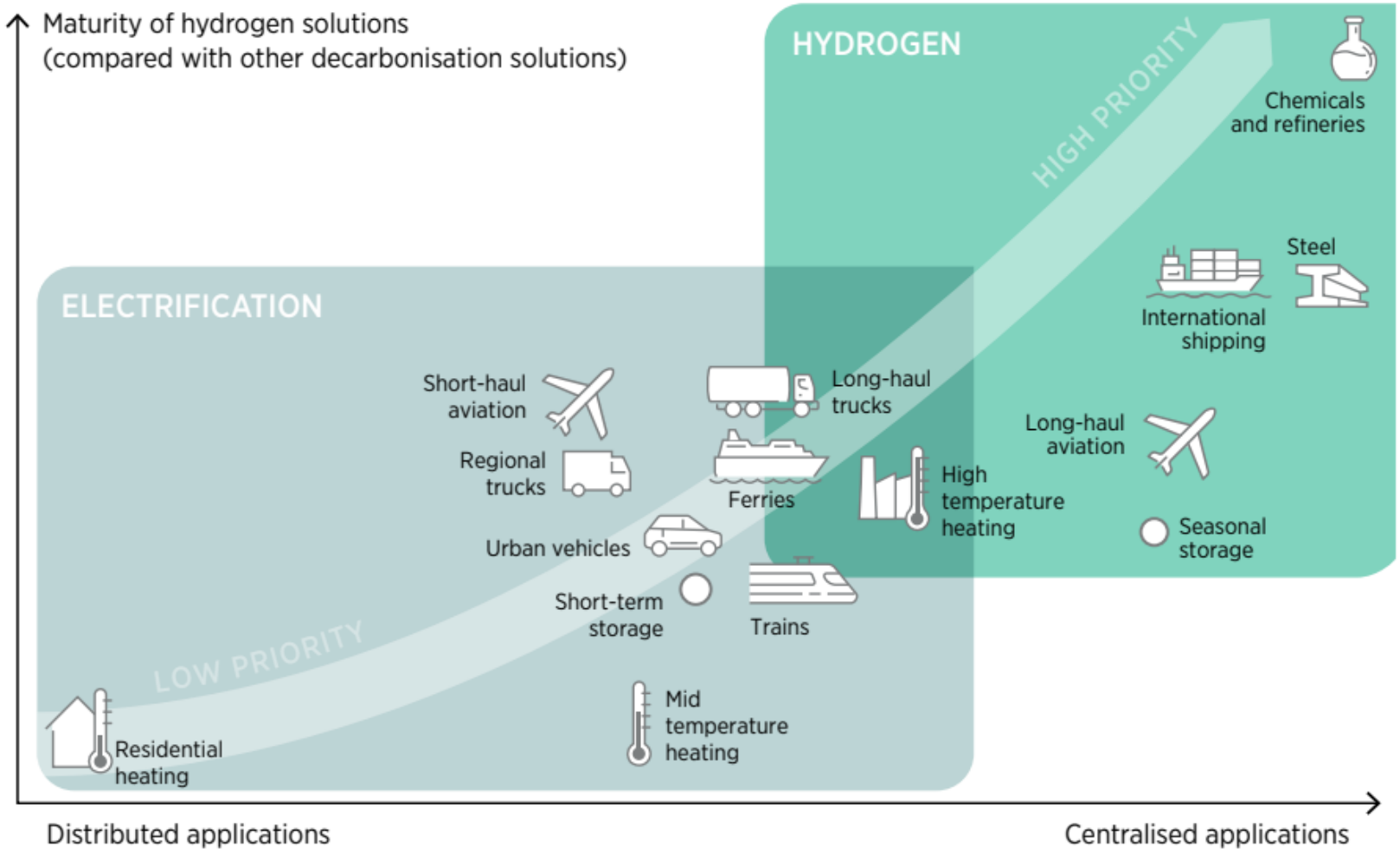
As well as different uses in the Mining Industry



** Via ammonia or e-fuel rather than H2 gas or liquid*

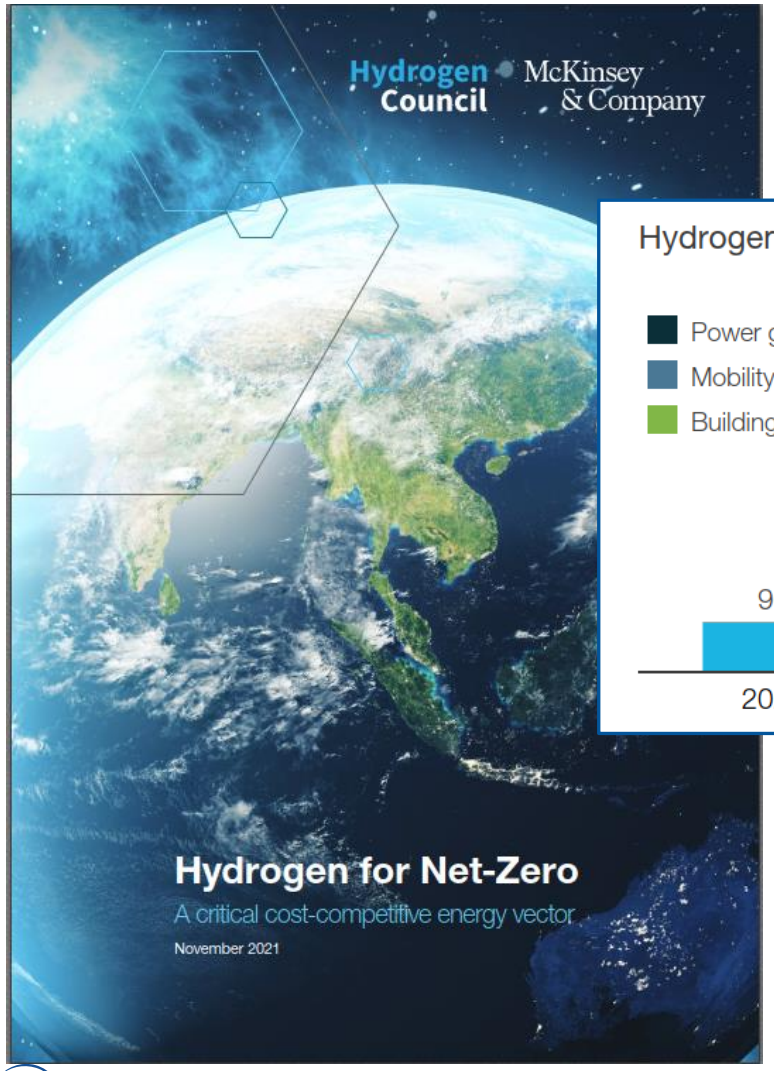
Source: Liebreich Associates (concept credit: Adrian Hiel/Energy Cities)

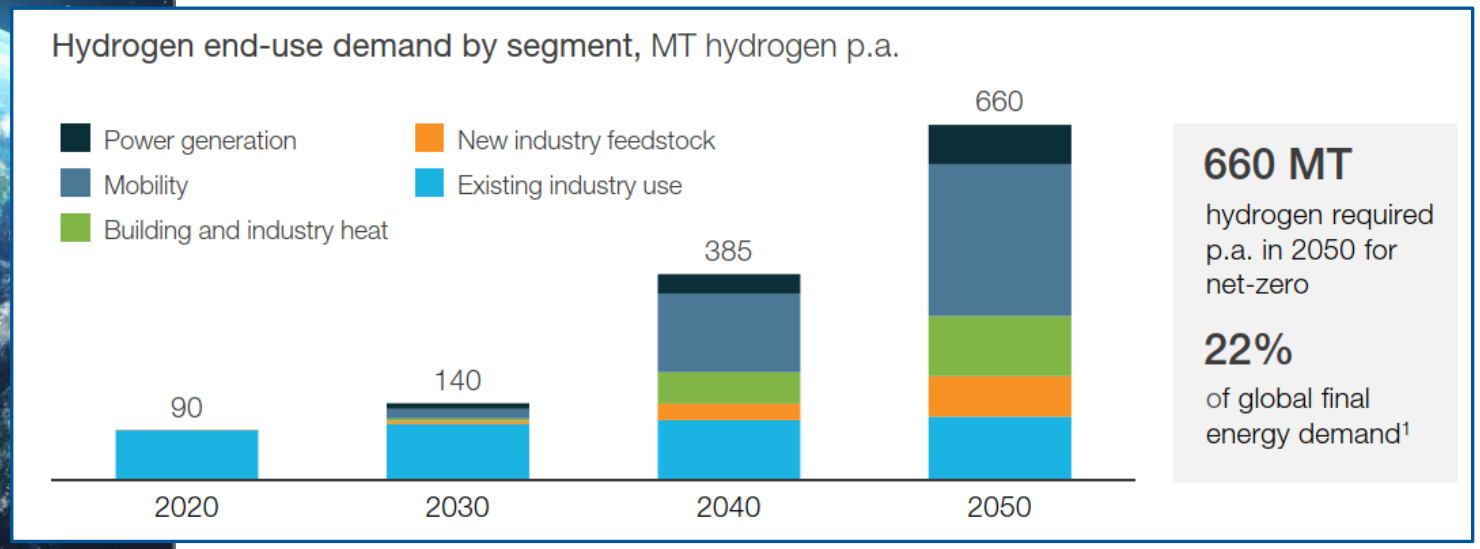
Complementarity between electrification and Hydrogen: Which green H2 applications make more sense?



Source: IRENA 2022.

Market Outlook for 2030 - 2050: Current and new H_2 demanding segments





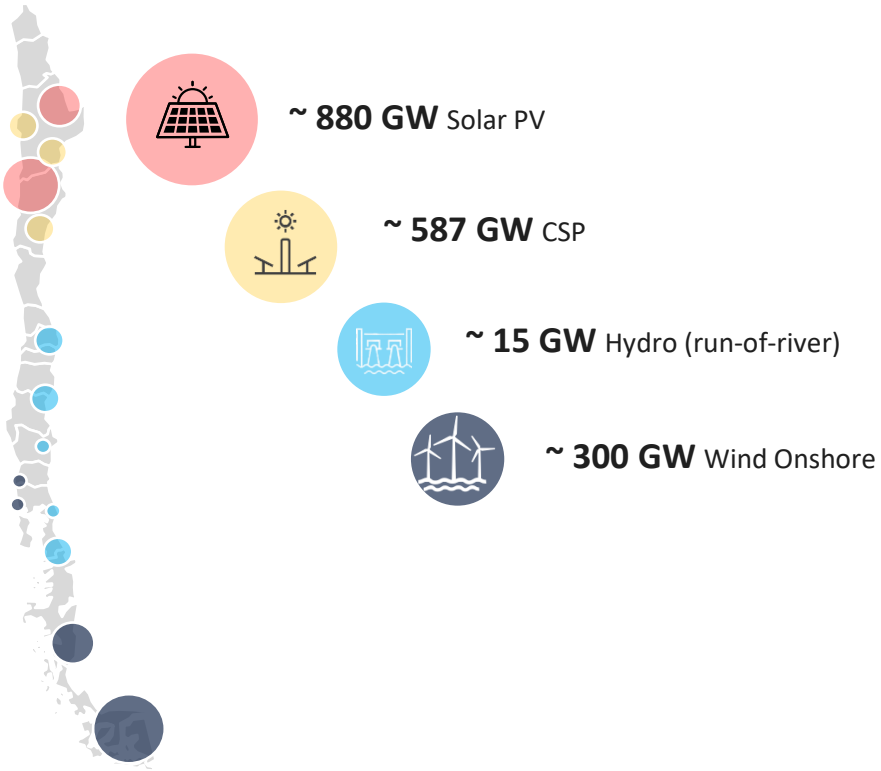
- **Refining is the easiest to convert from grey** to clean since it requires no additional equipment.
- Mobility is a new, growing demanding sector for H2 and its derivatives

3 Green H2: state of the art in Chile

Renewable Energies in Chile

Huge unexplored potential of renewable energies – huge Project Pipeline

Chile has about ~1,800 GW of unexplored renewable energy potential



~ 880 GW Solar PV

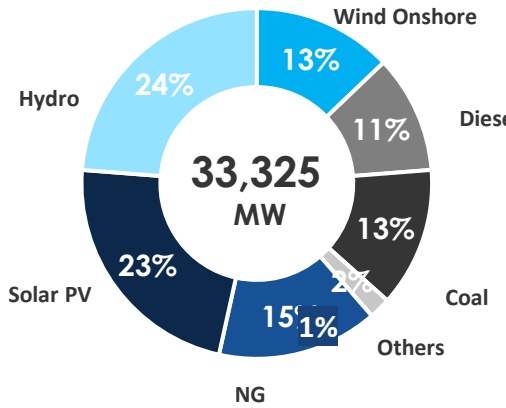
~ 587 GW CSP

~ 15 GW Hydro (run-of-river)

~ 300 GW Wind Onshore

GIZ, 2020 and Chilean Ministry of Energy (2021).

Total installed capacity in Chile in 2021 (MW)

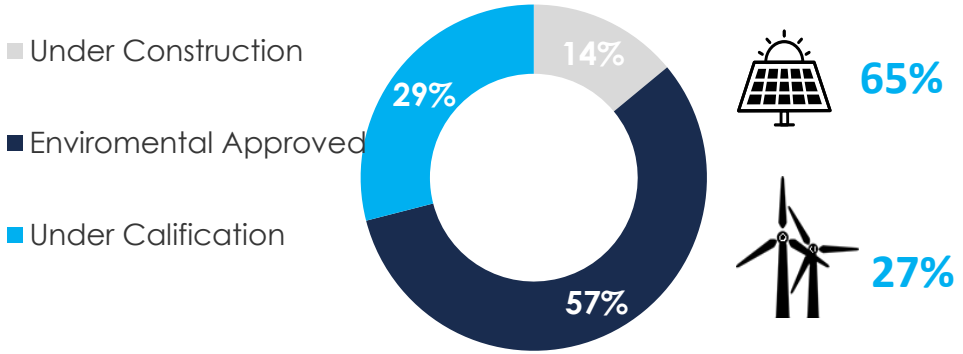


12.676 MW = ~ 38% RE (08/22).

Target for 2030: 70%

Source: *ACERA (August 2022).*

Current RE project pipeline (08/22)



65%

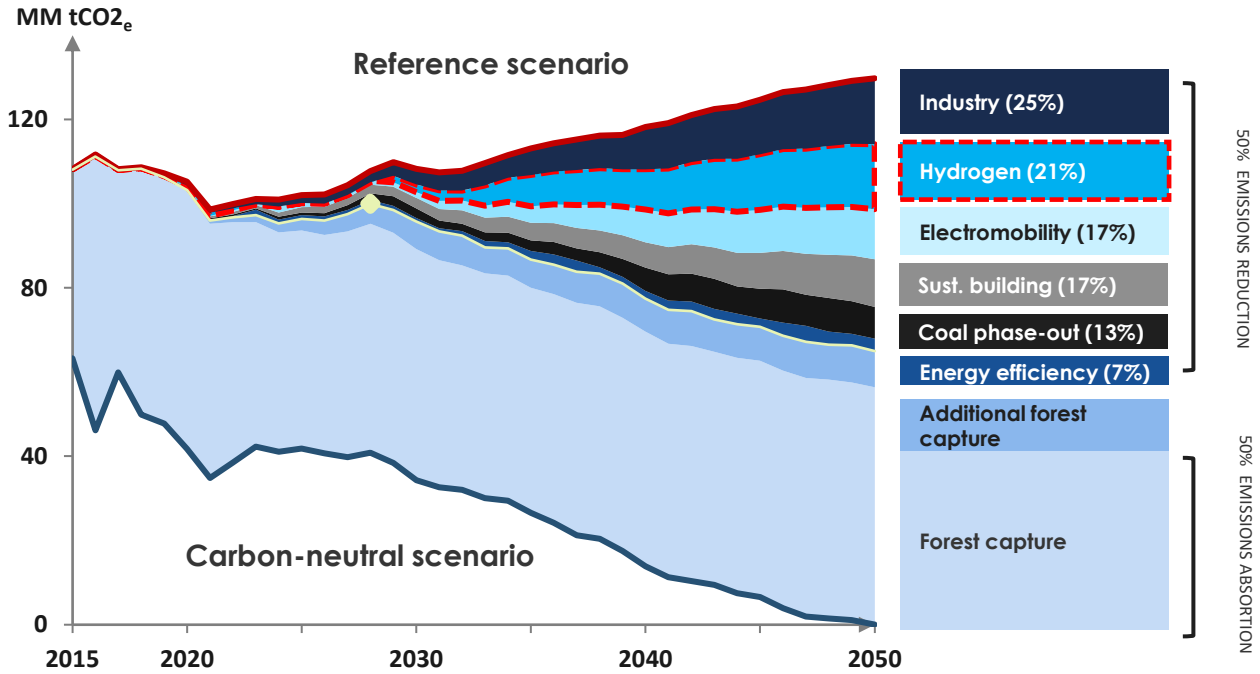
27%

Source: *ACERA (August 2022).*

Green H2 is a core element of Chile's commitment to become a net zero country by 2050

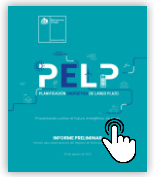
In April 2020, Chile presented **its updated NDC**, renewing its commitment to achieve CO2 emission reductions under the Paris Agreement by defining maximum CO2 emissions budgets.*

The emission reduction is aimed to be realized by **six action paths**, additionally to forest-based emission absorption:



According to Chile's carbon neutral scenario, H2 will contribute to **21% of national emission reductions in 2050**, broken down by 3 main applications:

	2050
• **As fuel in Cargo Transportation**	71%
• **Motor use in industry & mining**	12%
• **Gas replacement for residential and industrial uses (7% of the energy used for domestic hot water), Combined LNG-H2 for power generation.**	9%



Long-term energy policy PELP (2021):

- PELP highlights that the expansion of new technologies, such as electromobility and the deployment of the H2 industry, are crucial for fulfilling Chile's CO2 reduction commitments.

Long-Term Climate Strategy ECLP 2050 (2021):

- Refers to the H2-related NDC targets
- Defines renewable H2 as a key element in the context of decarbonizing the country.

Source: Ministry of Energy, 2021

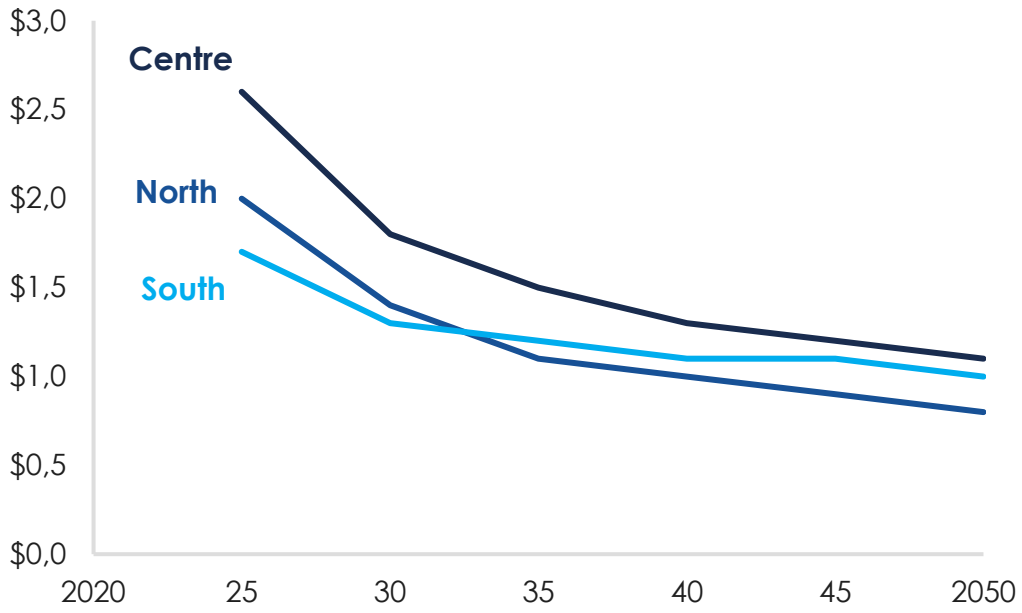
*The country set a carbon budget for the period 2020-2030 of a maximum 1,100 $MtCO_2e$ and absolute GHG emissions of 95 $MtCO_2e$ by 2030.

Renewable Hydrogen in Chile

Competitive advantages allow Chile to become a top exporter of H2 and its derivates

- **~70 kton** was the total demand of grey H2 in Chile by 2019 (additionally + ~200 kton H2 produced as Syn-Gas by Methanex for its Methanol Reactor).
- **Up to 50%** growth of H2 demand in Chile by 2030, according to official estimations.

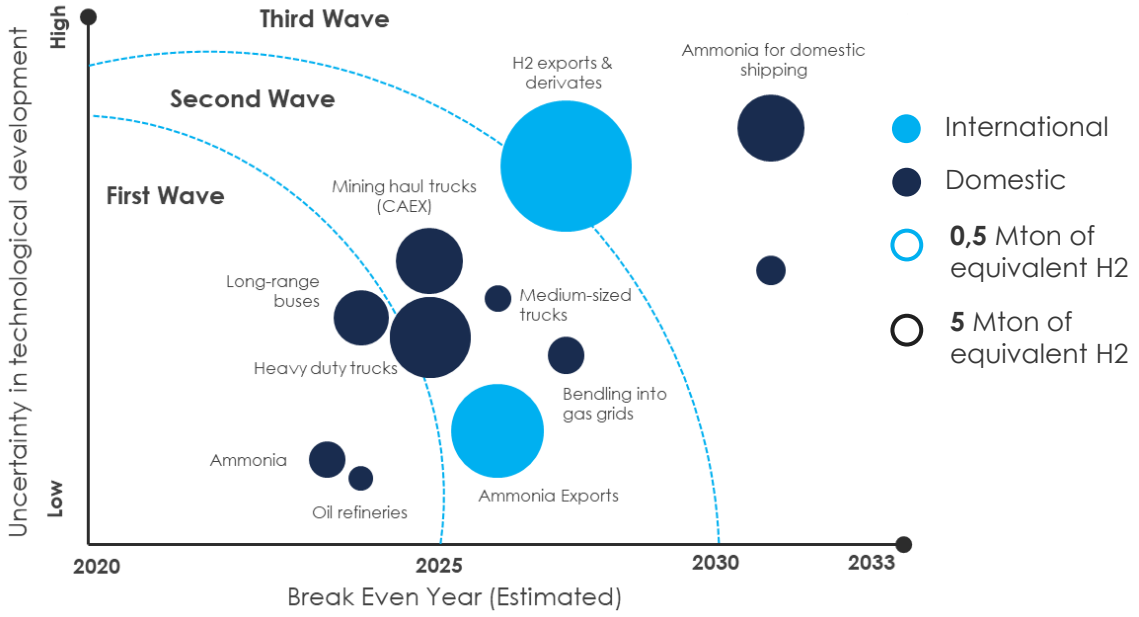
Levelized Cost of Renewable H2 in Chile
(USD/Kg H2)



Source: Chilean Ministry of Energy (2021).

- The lowest LCOH globally are expected to compensate transportation costs of H2 and its derivates to Asian and European markets
- **Chile is a frontrunner** in the LATAM region in terms of (foreign) investment, holding more Free Trade Agreements than any other country in the world (InvestChile, 2021).

National Hydrogen Strategy (Nov. 2020): Exportation and shipping fuels



Source: *Hinicio based on McKinsey analyses*

Chile's National H2 Strategy includes 8 inter-linked workstreams which promote several ongoing public and private initiatives

- The strategy is a **long-term national roadmap**, foreseeing that **the hydrogen industry could be as large as the mining sector**, which contributes nearly 15% to Chile's GDP.
- According to its National H2 Strategy, **the country has the ambition of being globally recognized as the top producer and exporter** of renewable H2 and its derivatives.

The Government's Action Plan is based on 8 workstreams:

1. Strategy and targets
2. Regulation & permits
3. Value chain development
4. Incentives and financing
5. Infrastructure
6. Coordination & alliances
7. Research & Development
8. Human Capital

Key targets of the National Green Hydrogen Strategy

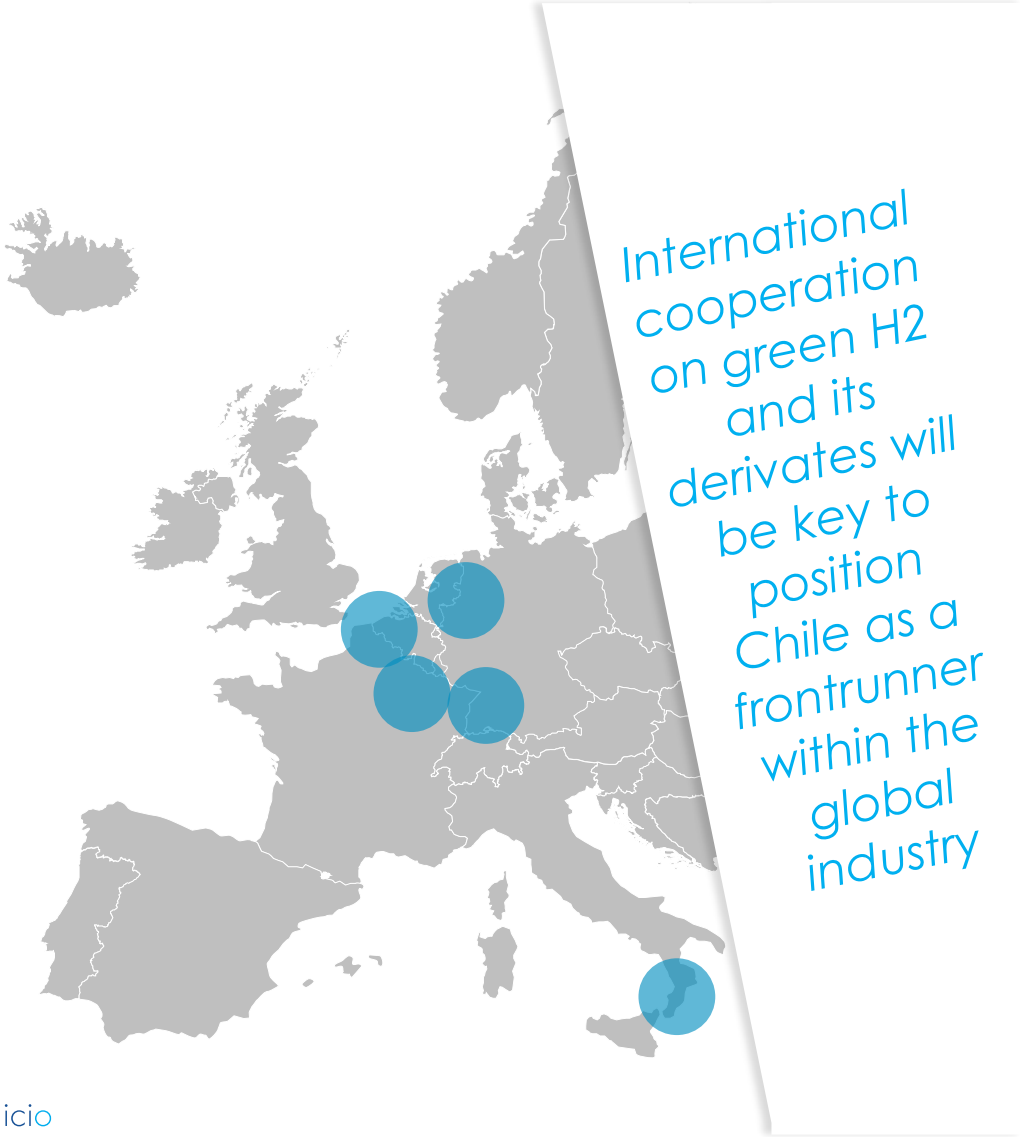
2025

- **5 GW** of electrolysis (EZ) capacity operating or under development
- Production of **100 Kton H2/year**
- Become the **top #1 destination for H2 investment** in LATAM

2030

- Be among the 3 top global renewable H2 + derivatives exporters with an **exportation market of 2.5 Bn USD/year**
- 25 GW of installed EZ capacity
- The **world's most cost-effective** renewable H2 producing country.

Strategic alliances in key areas as exportation and R&D are also key for the deployment of the industry

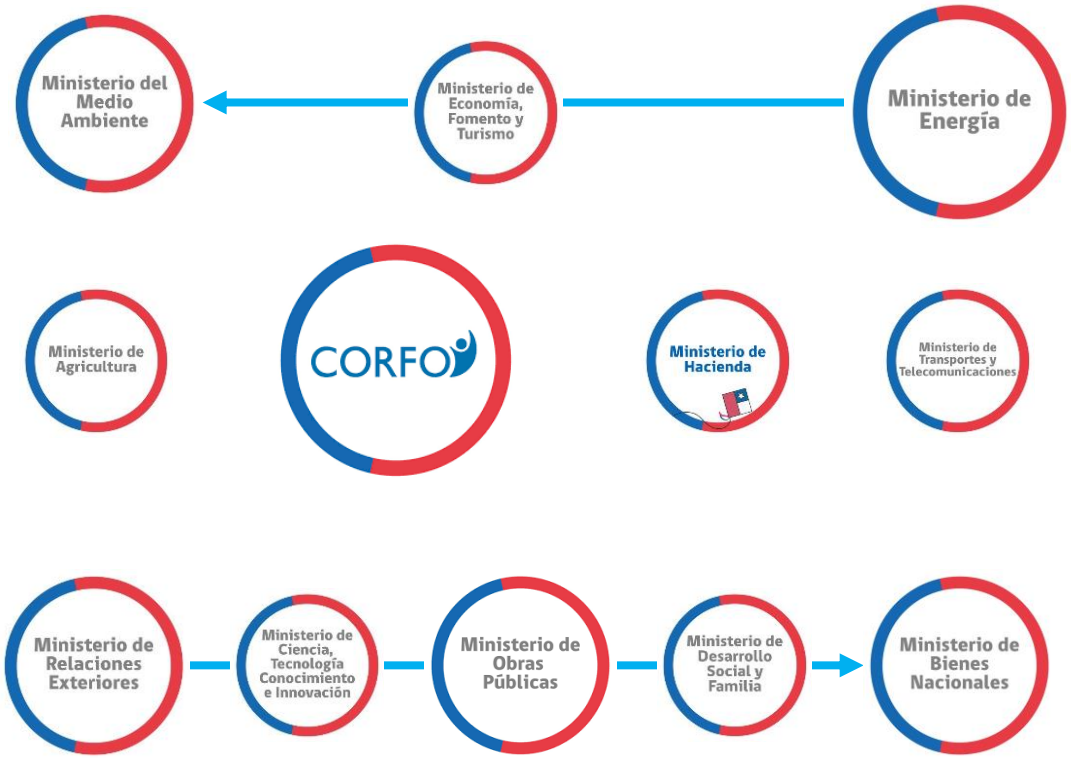


International cooperation on green H2 and its derivates will be key to position Chile as a frontrunner within the global industry

- Energy Partnership Chile-Germany launched in 2019, both countries signed a letter of intent to build up an H2 economy. Under this partnership, concrete initiatives have already initiated, e.g a future H2-based Syn-fuel export secured by the HIF- Project Haru Oni in Magallanes Region.
- The Netherlands (Port of Rotterdarm) and Chile have signed an MoU for the development of import-export alternatives for renewable hydrogen.
- Singapore and Chile are developing cooperation around H2 deployment through information exchange and a study of potential exports from Chile to the Port of Singapore.
- Chile signed another MoU with the Belgian ports of Antwerp and Zeebrugg at COP26 in Glasgow, to foster renewable hydrogen trade. Belgian Ports aim to distribute hydrogen for future European demand.
- France and Chile have agreed to a concrete work plan for the development of green hydrogen opportunities. The Alliance seeks to build synergies between H2 projects in both countries.
- Chile and South Korea have agreed an MoU for hydrogen energy cooperation. The alliance seeks to benefit from Chile's renewable potential and South Korea's experience in technologies for ramping-up a hydrogen market.
- The Institute of Energy Economics from Japan signed a mutual collaboration with Chile on green H2 and its derivates topics.

Chile's Government ratified its commitment to promote the industry with the launch of the First Interministerial Council on green H2

11 Ministries forming part of the Green H2 Council



Some of the main functions of this Interministerial Council are:

- Articulate initiatives from the State through CORFO
- Promote capacities to generate green H2 technologies and applications in Chile (including technology and knowledge transfer).
- Promote the training of specialized professionals and technicians.

Source: bnamericas.com

Renewable H2 projects are emerging across the whole country - located in **4 main projected H2 valleys**

H2 Valley

Pre-fid
Development
Operation

1 AES "Green Ammonia"
NH3 for export
AES + international partner
800MW RE

2 HyEx
NH3 for local use and export
Engie, Enaex
850 MW (RE)

3 Paracelsus
Power-to-Mobility
Humboldt H2V, Mejillones Port
Pilot: 550 H2 ton/year

7 ACH – MRP Project
NH3 for export
Maisntream, Aker Clean Hydrogen
3,000 MW (hybrid)

9 Quintero Bay H2 Hub
Power-to-X
GNL Quintero, Enagas, Acciona
10 MW (RE)

10 Hypro Aconcagua
Power-to-Gas
Linde
20 MW RE

11 H2 for Forklifts in retail
Power-to-mobility
Engie, Walmart
1 MW (RE)

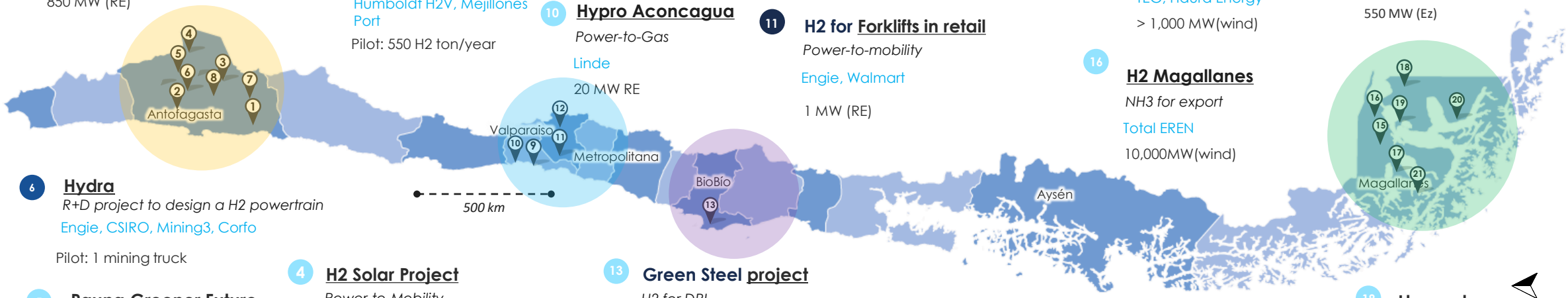
15 HNH Energy
NH3 for export
Austria Energy, Okowind, CIP
1,800 MW (wind)

19 Haru Oni
Highly Innovative Fuels (HIF)
AME, Enel, ENAP, Porsche y Siemens Energy
Pilot: 131 m³ e-gasoline/year

21 Gente Grande
NH3 for export
TEG, Haura Energy
> 1,000 MW(wind)

20 Magellanic Winds
NH3 for export
RWE
550 MW (Ez)

16 H2 Magallanes
NH3 for export
Total EREN
10,000MW(wind)



6 Hydra
R+D project to design a H2 powertrain
Engie, CSIRO, Mining3, Corfo
Pilot: 1 mining truck

5 Pauna Greener Future
NH3 for export
Statkraft
671 MW (PV)

4 H2 Solar Project
Power-to-Mobility
Air Liquide, Atamostec, CEA Liten
Pilot: 1-3 FC buses

8 AMER project
E-Methanol
Air Liquide
80 MW RE

13 Green Steel project
H2 for DRI
CAP Acero, Paul Wurth
Confidential

12 Las Tortolas project
Power-to-mobility (1 forklift)
Anglo American
186 kW

14 HDF Project
Power to Power
Hydrogene de France
36 MW (wind)

17 Faro del Sur
Hydrogen
ENEL Green Power
240 MW (wind)

18 Llaquedona
NH3 for export
Sociedad de Inversiones Albatros, Alfanar, ENAP
1,159 MW (wind)

Note:
Project's location only referential
Developers highlighted in turquoise

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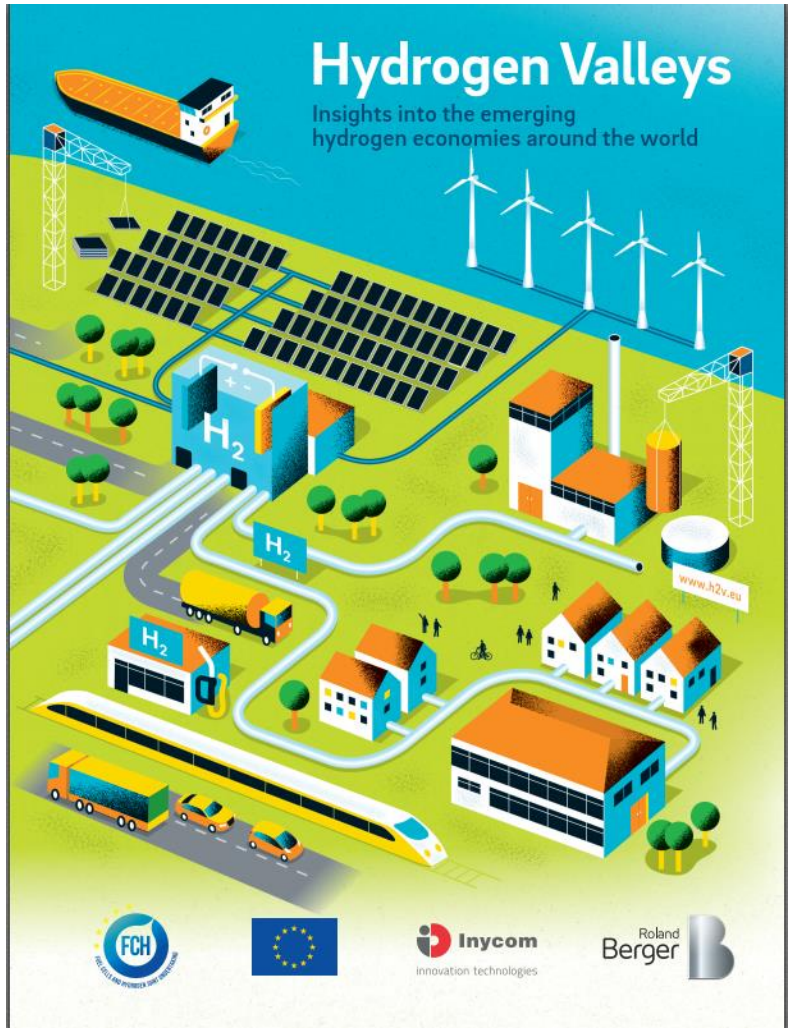
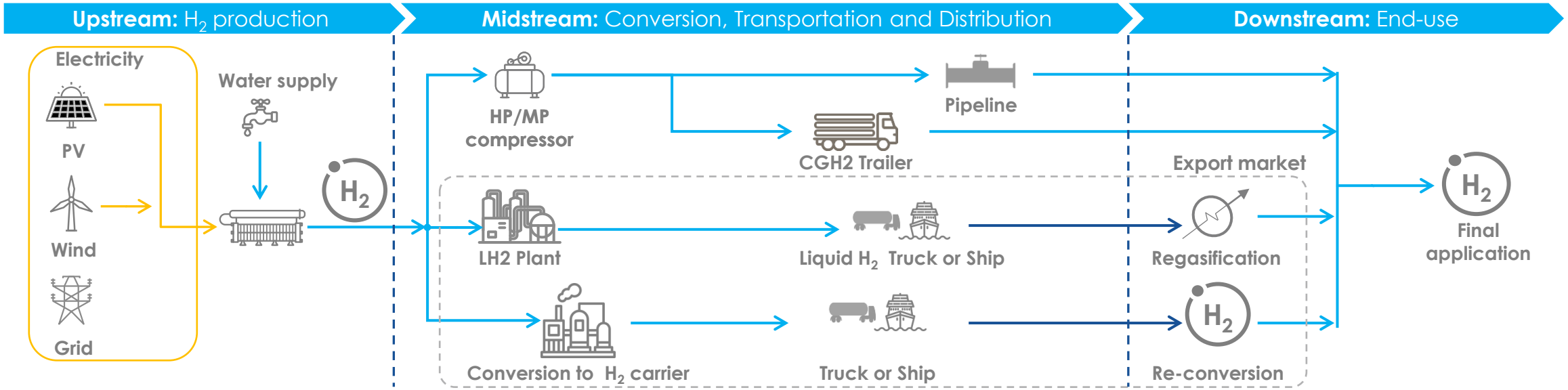
Hydrogen Valley?



A "Hydrogen Valley" is a geographical area – a city, a region, an island or an industrial cluster - where **several hydrogen applications are combined together** into an integrated hydrogen **ecosystem** that **consumes a significant amount of hydrogen**, **improving the economics** behind the project. It should ideally cover the entire hydrogen value chain: production, storage, distribution and final use.

4 The role of Ports in the emerging H2 economy

Ports are a **crucial part** of the H2 Midstream and Downstream supply chain infrastructure



INFRASTRUCTURE REQUIRED

Upstream

- Renewable Energy Plants
- Transmission lines
- Electrolysis Plant
- Water supply

Midstream

- H2 compression and storage
- Hydrogen pipelines
- Compressed gas hydrogen trailer (CGH2)
- Liquefaction plants and liquid hydrogen trucks
- Conversion plants to a hydrogen carrier: Ammonia, Liquid Organic Hydrogen Carrier (LOHC), Methanol
- **Trucks for transportation or ships for longer distances.**
- **Port Infrastructure for NH3; LH2, LOHC, synfuels**

Downstream

- Regasification plant to convert liquid hydrogen to gaseous hydrogen
- Re-conversion plant to convert hydrogen carrier to hydrogen.
- Equipment needed for the final application of H2.

Ports' **strategic role:** There are several **drivers for H2 port infrastructure development**

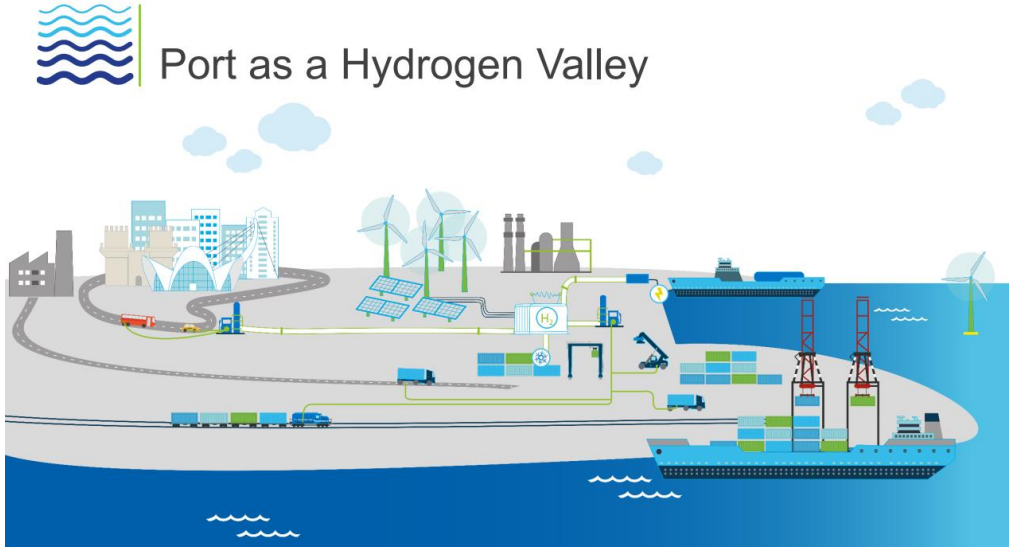
Ports could be the **nerve center for the production and consumption of decarbonized hydrogen**

Capitalizing on existing liquefied natural gas infrastructure could foster the development of hydrogen import-export. **Natural gas networks,** often present in ports, are also potential opportunities for **hydrogen injection and blending.**

Ports may be strategic places for the transition to the scale of the sector: They are often **first-rate industrial and logistical centers** and **hold the current demand opportunities (refineries, ammonia, chemistry**, etc.)

Ports could become an avenue for the development of **pilot-scale green electricity generation projects**, close to exportation channels.

Ports' clients like mining industry, need to address their **scope 3 emissions** – this requires a fully "clean" supply-chain. **In this line, hydrogen also can decarbonize freight transport transiting through ports: port equipment (transport – handling), road freight, or ships and boats (propulsion, on-board electricity, dockside connections, etc.)**



What is the **role of Neltume ports** within this emerging economy?

H2 export market will require significant investment in infrastructure across the hydrogen supply chain

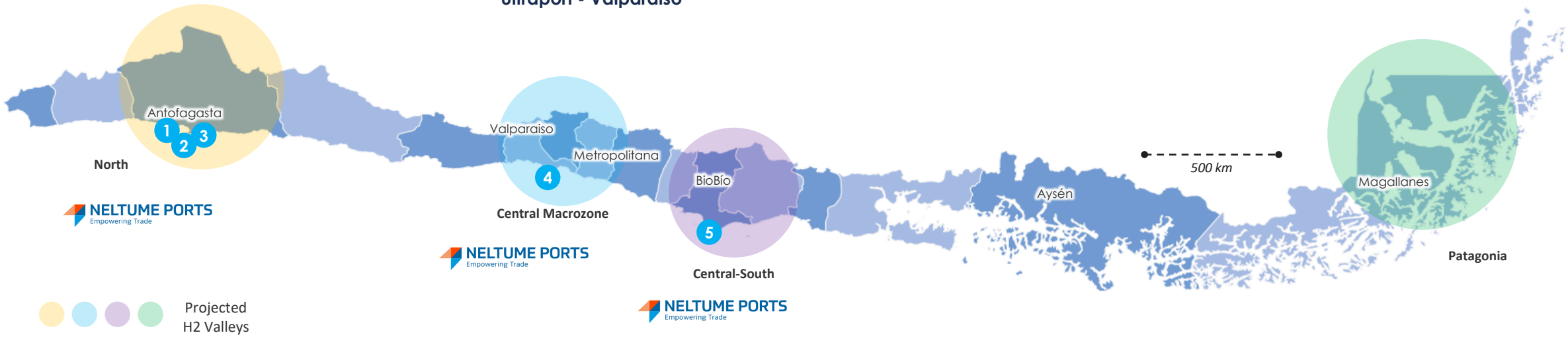
1 **TGN - Mejillones**

2 **Puerto Mejillones - Mejillones**

3 **Puerto Angamos - Mejillones**

4 **Ultraport - Valparaiso**

5 **Puerto Coronel - Concepción**



Strategic location:

Five Neltume ports facilities are located in hydrogen valleys.

- **New Pipelines and port infrastructure** will be needed both in the North and Patagonia.
- **Also close-to-ports-located local industries' H2 demand will** grow over the next decades.
- Industrial clients may require "cleaner" logistic services
- There are several business opportunities for ports within the emerging H2 economy which need to be analyzed case-by-case.

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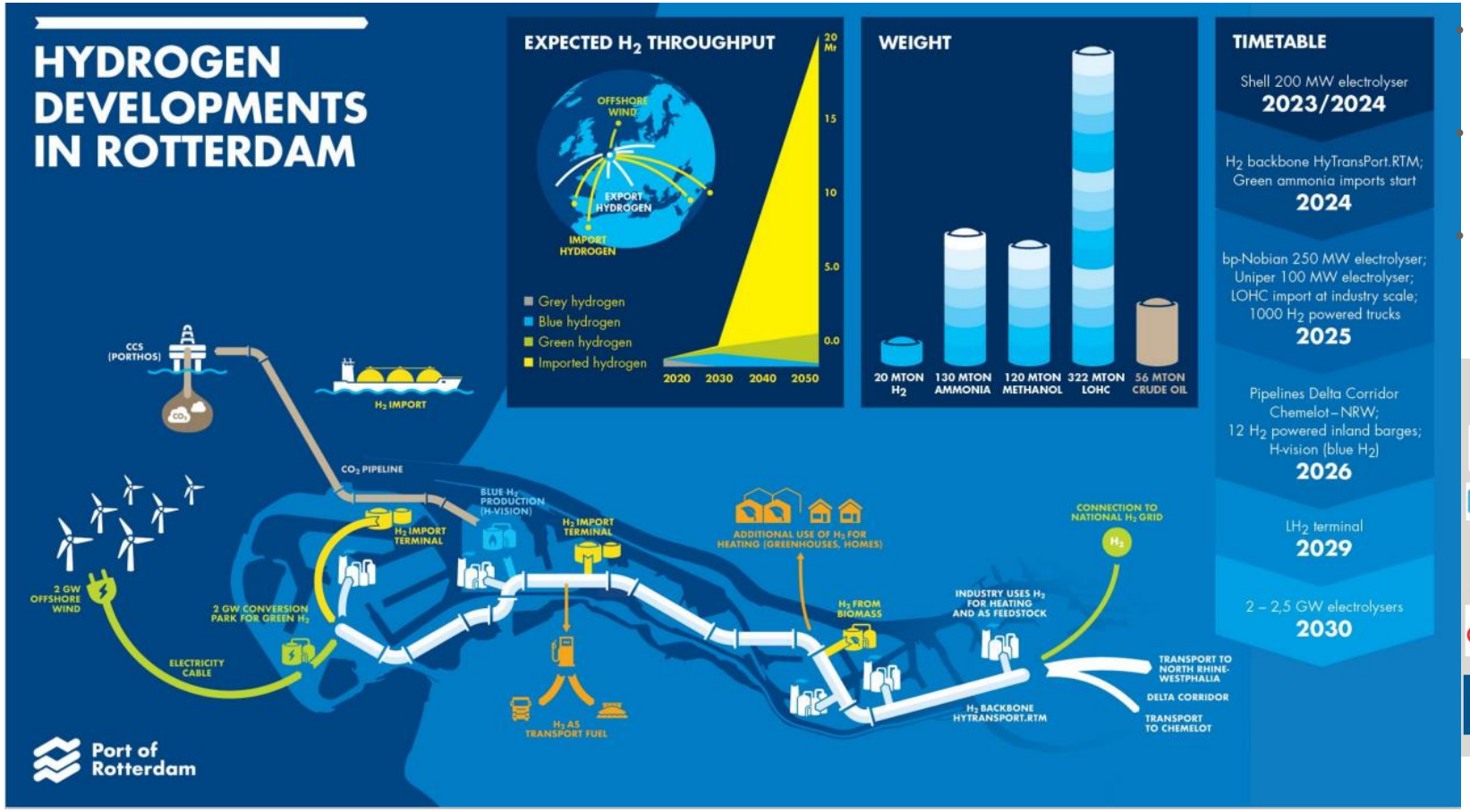
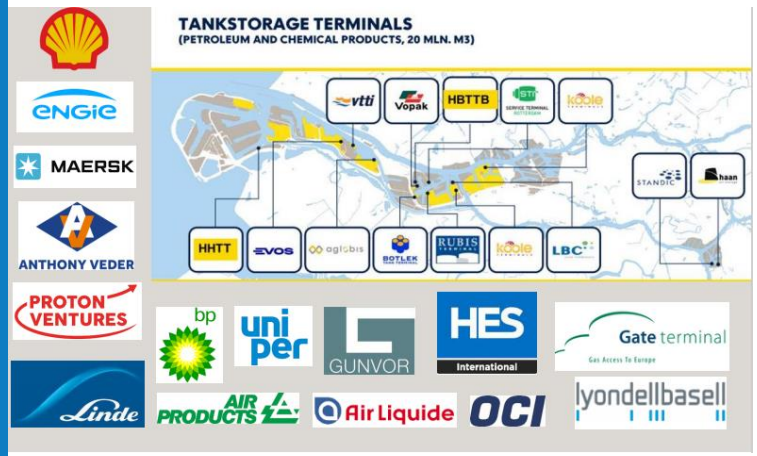
Worldwide, ports as **Rotterdam, Amsterdam and Vancouver,** among others, are moving quickly **to become H2 hubs**

Port of Rotterdam



- **Partnering** is key for developing a hydrogen HUB. More than 100 companies in Rotterdam involved in industrial activities.
- Public Investment in infrastructure (€1 – 1,5 billion) lead to multiple private investments (€ 4 – 5 billion).
- Port of Rotterdam has a key role in the supply chain puzzle



Source: Port of Rotterdam

Muchas gracias

Contact

Nuria Hartmann

Manager Strategy and Business Consulting

Office Santiago de Chile

http://www.hinicio.com

Nuria.Hartmann@hinicio.com

https://www.linkedin.com/company/hinicio

https://twitter.com/HinicioSA